

TABLE 3.—Total number of periods of two or more consecutive days in which wind movement did not equal 10 miles per hour for five or more consecutive hours each day, for the 10 years 1912 to 1921, inclusive, at Lincoln, Nebr.

Number of consecutive days	January	February	March	April	May	June	July	August	September	October	November	December	Total for 10 years
2	11	11	3	8	9	5	8	13	17	12	6	17	120
3	5	3	1	4	4	4	10	5	5	3	3	7	57
4	1	1	1	0	0	0	6	6	2	3	3	4	29
5	0	0	0	0	0	0	2	3	0	0	1	1	12
6	0	0	0	0	0	0	1	1	1	0	0	0	8
7	0	0	0	0	0	0	2	1	1	0	0	0	4
8	0	0	0	0	0	0	1	0	0	0	0	0	3
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	1
13	0	0	0	0	0	0	0	1	0	0	0	0	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0
16	1	0	0	0	0	0	0	0	0	0	0	0	1

Since the amount of electricity used on farms depends mainly upon the amount used for lighting purposes, more electricity is consumed during the months when nights are longer, and the batteries then require more frequent charging. A comparison between the hours of

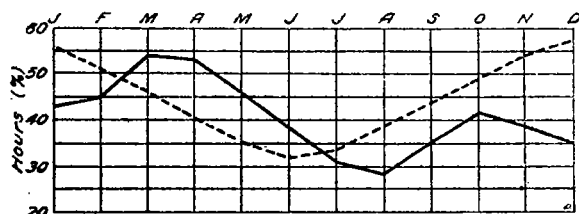


FIG. 4.—Percentage of hours with wind velocity equaling or exceeding 10 miles per hour (unbroken line), and percentage of hours of darkness (broken line), at Lincoln, Nebr., for the 10 years, 1912 to 1921, inclusive

TABLE 4.—Recorded average hourly wind movement (miles) at certain Weather Bureau stations, with height of anemometer

Station and height of anemometer	January	February	March	April	May	June	July	August	September	October	November	December	Year
Lincoln (84 feet).....	10.7	11.3	12.6	13.0	11.2	10.1	8.9	8.6	9.7	10.5	10.4	10.2	10.6
North Platte (51 feet).....	7.6	8.1	9.5	10.4	9.1	8.1	7.2	6.8	7.5	7.8	7.8	7.4	8.1
Omaha (122 feet).....	9.1	9.7	10.1	10.1	8.9	7.8	6.9	6.7	7.5	8.2	8.6	8.7	8.5
Sioux City, Iowa (164 feet).....	12.3	12.7	13.6	14.6	13.2	11.8	10.1	9.9	11.4	12.2	11.9	11.6	12.1
Valentine (54 feet).....	9.8	9.8	11.3	12.4	11.6	10.7	9.7	9.1	10.0	10.2	9.7	9.5	10.3

CLIMATOLOGICAL DATA FOR ANDAGOYA, REPUBLIC OF COLOMBIA, SOUTH AMERICA

551.58 (86)

By P. C. DAY

[Weather Bureau, Washington, D. C., Aug., 1926]

Through the courtesy of Mr. E. H. Westlake, vice president, Pacific Metals Corporation, 61 Broadway, New York, N. Y., the Weather Bureau has received regularly for a number of years, copies of the monthly meteorological records made at the mining camp of that corporation at Andagoya, located on the San Juan River in the northwestern part of Colombia, South America. The geographic coordinates of the place of observation are, latitude 5° 4' north, longitude 76° 55' west, in the Choco district, at the junction of the San Juan and Condoto Rivers, and about 250 feet above sea level.

On the west the distance in a direct line to the Pacific is about 35 miles, while to the east lie the Western Cordillera of the Andes at a distance of about 50 miles. These mountains are from 4,000 to 5,000 feet above sea level.

darkness and the wind movement is given in Figure 4. Darkness is considered as beginning one-half hour after sunset and ending one-half hour before sunrise.

The average wind velocity at the regular Weather Bureau stations in Nebraska and also at the neighboring station at Sioux City, Iowa, is shown in Table 4. The height of the anemometer at each station is shown. Since wind velocity increases with increase in elevation, the height of the anemometer should always be considered when comparing records from different stations.

In order to give a better comparison of the wind movement at the different weather bureau stations the averages were reduced to a common level. As the windmill at the Agricultural College at the University of Nebraska is 60 feet high the averages were reduced to this level. The formula used in making the reductions was suggested by Stevenson in the Journal of the Scottish Meteorological Society in 1880:

$$V = v \sqrt{\frac{H+72}{h+72}}$$

in which V is the computed velocity for the level H , in terms of the known velocity v , at the known height h .

These computed velocities are given in Table 5. While there may be a small error, they undoubtedly give a better indication of the variation in wind movement over the State than the actual averages in Table 4.

TABLE 5.—Computed average hourly wind movement (miles) at stations given in table 4, reduced to an elevation of 60 feet

Station	January	February	March	April	May	June	July	August	September	October	November	December	Year
Lincoln.....	9.8	10.4	11.6	12.0	10.3	9.3	8.2	7.9	8.9	9.7	9.6	9.4	9.8
North Platte.....	7.9	8.4	9.9	10.8	9.5	8.4	7.5	7.1	7.8	8.1	7.7	7.7	8.4
Omaha.....	7.6	8.1	8.4	8.4	7.4	6.5	5.7	5.6	6.2	6.8	7.1	7.2	7.1
Sioux City, Iowa.....	9.2	9.5	10.2	11.0	9.9	8.8	7.6	7.5	8.6	9.2	8.9	8.7	9.1
Valentine.....	10.0	10.0	11.5	12.6	11.8	10.9	9.9	9.3	10.2	10.4	9.9	9.7	10.5

In conclusion it may be said that while the data presented may not prove the feasibility of operating electrical generators by wind power, they at least show the possibilities. It would seem that here is a fruitful field for further investigations. The day may not be far distant when hundreds of rural homes will have wind power plants for generating electricity.

Between the San Juan River and the Pacific coast lies a range of hills not over 300 feet above sea level.

The instrumental equipment consists of maximum and minimum thermometers, raingage, and hygrometer, all of standard make and properly exposed. The thermometers are read daily and the precipitation is measured twice daily, 7 a. m. and 7 p. m., local sun time.

Observations of rainfall began in August, 1914, and of temperature in September, 1917. A short record of relative humidity was made during portions of 1917 and 1919.

In addition to the above a record of precipitation covering about three years was furnished by the same company from a branch camp at Buena Vista, about 25 miles north of the main camp at Andagoya.

TABLE 1.—Means and extremes of temperature (°F.), 1917–1925, Andagoya, Colombia

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean maximum.....	89.6	89.3	89.6	89.8	89.2	89.2	89.3	89.2	89.5	89.6	88.2	88.0	89.2
Mean minimum.....	74.5	74.5	74.5	75.0	74.5	74.1	73.6	73.6	73.5	73.8	73.7	74.0	74.1
Mean.....	82.0	81.9	82.0	82.4	81.8	81.6	81.4	81.4	81.5	81.7	81.0	81.0	81.6
Highest.....	96	95	98	97	96	100	100	98	100	99	95	96	100
Lowest.....	68	71	70	70	72	70	70	70	70	69	68	66	66

The mean annual temperature 81.6° is exceeded in very few regions of South America. The following means are of interest in this connection: 82.4° at Quixeramobim, State of Ceara, Brazil; 82.6° at Dada-Nawa in southern British Guiana; and 83.5° at Maracaibo, Venezuela. In the warmest months, January to April, the mean temperature at Andagoya averages 82.1°.

TABLE 2.—Monthly and annual precipitation (in inches), Andagoya, Colombia

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1914.....								14.45	26.11	23.43	11.75	22.15	
1915.....	19.93	23.65	17.30	16.77	15.16	10.62	32.91	24.18	29.96	29.00	25.67	17.23	275.28
1916.....	26.81	16.76	26.29	26.50	21.81	34.14	31.31	33.23	20.71	29.43	23.57	20.33	310.39
1917.....	19.89	26.25	19.30	39.15	30.16	18.61	29.10	27.01	29.12	24.49	28.65	25.32	317.05
1918.....	20.33	25.95	24.34	23.59	24.55	30.46	25.06	28.14	16.85	17.09	31.30	20.20	294.16
1919.....	14.51	13.60	8.55	19.86	20.77	28.96	26.16	22.51	16.01	15.37	30.30	21.11	237.71
1920.....	25.39	13.35	24.28	20.40	29.94	24.44	25.85	26.76	26.92	21.96	25.21	23.76	288.16
1921.....	36.29	25.86	19.54	30.43	21.42	29.79	17.30	33.40	27.74	17.90	18.87	19.50	298.04
1922.....	32.85	28.22	26.65	22.58	36.06	20.59	12.56	25.93	26.36	23.95	23.92	19.40	298.97
1923.....	27.41	13.78	13.60	31.92	20.35	23.95	18.88	27.33	47.83	21.08	20.61	20.79	297.59
1924.....	25.23			28.88	24.36	20.33	23.51	17.96	20.61	20.37	19.27	13.11	
1925.....	16.44	14.39	8.69		19.25	25.57	17.12	18.67	22.53	15.06	17.97	17.63	
Mean.....	24.10	20.18	18.86	26.01	24.28	25.13	23.61	25.80	25.88	21.67	23.09	20.50	279.11
Mean, 7 p. m. to 7 a. m. ¹	20.58	16.52	14.43	20.25	17.86	19.56	18.60	19.92	21.27	17.33	17.09	16.18	219.59
Mean, 7 a. m. to 7 p. m. ¹	3.52	3.66	4.43	5.76	6.42	5.57	5.01	5.88	4.61	4.34	6.00	4.32	59.52
Maximum in 24 hours.....	7.34	5.90	8.11	6.22	5.41	6.80	3.36	5.14	6.04	6.24	4.67	4.35	8.11
Maximum in 12 hours.....	6.87	3.95	8.04	5.90	5.39	6.02	3.33	5.12	6.00	4.05	3.92	3.82	8.04
Mean number of days with precipitation.....	26	21	23	25	26	24	26	27	27	24	27	27	303

¹ Hours of measurement changed to 6 p. m. and 6 a. m. in March, 1925.

The temperature is unusually uniform throughout the year; during the eight-year period, the maximum ob-

served, 100° F., was recorded on only four days, the minimum of 66° on but one date, and the minimum was below 70° on only five days.

The individual monthly amounts for the period of record at Andagoya show the rainfall to be rather uniformly distributed over the several seasons, as well as over the different years of the period, a feature not usual in regions with such heavy annual amounts. Individual monthly totals ranged from 8.55 to 47.83 inches, but they were generally between 20 to 30 inches.

The feature of outstanding importance in the distribution of precipitation is the great frequency and intensity of night rains. The average annual number of nights with rain is 277, while the average for the day falls to 158. Nearly 80 per cent of the precipitation occurs between 7 p. m. and 7 a. m., as shown in the table given, and for this period the mean intensity for nights with rain is about 0.80 inch as compared with less than 0.40 inch for the daytime intensity. Contrary to what might well be expected, the extreme amounts of precipitation recorded in 24 hours are rather moderate, and those for 12 hours are not excessively high. The maximum amounts for these periods are due to heavy downpours at night, the heaviest fall for any 12-hour period of daylight being only 3.10 inches.

At Buena Vista the average for the three-year period is more than 50 inches greater than at Andagoya, but the measurements there are made once daily only and the relative proportions for the day and night periods are not shown.

The mean annual precipitation of 279 inches at Andagoya and an even greater amount, 331 inches, at the sub-station, Buena Vista, together with a 7-year average precipitation of about 280 inches as recorded from 1910 to 1916 at Buenaventura, located south of Andagoya at the mouth of the San Juan River, show remarkable contrasts to those occurring in the region east of the Cordillera Occidental, the western range of the Andes. The decrease in annual rainfall from the coast to the elevated interior amounts to more than 250 inches, as shown in the following table. The marked differences in the annual amounts are likewise maintained in the monthly amounts for the different seasons.

TABLE 3.—Mean monthly and annual precipitation (inches), at six stations in Colombia

Stations	Length of record in years	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Andagoya ¹	12	24.10	20.18	18.86	26.01	24.28	25.13	23.61	25.80	26.88	21.67	23.09	20.50	279.11
Buena Vista ²	3	20.51	14.58	17.85	31.60	30.77	27.29	38.23	25.98	30.86	26.78	35.41	30.87	330.72
Buenaventura ³	7	17.90	12.33	11.34	25.60	28.40	23.76	22.35	26.66	27.93	34.66	28.08	21.64	280.65
Medellin ⁴	15	2.70	3.27	3.36	6.53	7.89	5.44	4.13	4.68	6.16	7.02	5.07	2.33	58.78
La Manuelita ⁵	11	3.19	2.10	4.16	6.09	5.37	2.92	1.50	1.49	2.98	5.81	4.78	3.20	44.59
Bogota ⁶	29	2.37	2.42	3.77	5.44	4.28	2.11	1.78	1.96	2.20	5.57	5.06	3.00	39.96

¹ 5° 4' N., 76° 55' W., elevation 250 feet. Period, 1914–1925.

² 5° 30' N., 76° 51' W., elevation not given. Period, 1923–1925.

³ 3° 49' N., 77° 11' W., near sea level. Period, 1910–1916.

⁴ 6° 10' N., 75° 45' W., elevation 4,950 feet. Periods, 1875–1878 and 1908–1918.

⁵ 3° 36' N., 76° 27' W., elevation 3,500 feet. Period, 1900–1910.

⁶ 4° 36' N., 74° 5' W., elevation 8,700 feet. Period, 1894–1922.

Sources of data:

BUENAVENTURA AND BOGOTA: SARASOLA, S., *Noticia del nuevo observatorio (San Bartolomé de Bogotá) con algunos datos sobre la climatología y magnetismo de Colombia*. Bogotá, 1921.

MEDELLIN: Climatological Data, West Indies and Caribbean Service, U. S. Weather Bureau. July, 1925.

LA MANUELITA: CHAPMAN, FRANK M., *The Distribution of Bird Life in Colombia*. *Bulletin of the American Museum of Natural History*, vol. 36, 1917.

The annual precipitation over the coast districts and lower valleys of northwestern Colombia, nearly 300 inches, as shown in the above table, is apparently the highest that occurs in either North or South America, being considerably in excess of the amount received at Mooretown, Jamaica, 222 inches, or at Greytown, Nicaragua, 256 inches.

In commenting on the heavy precipitation in that region, the assistant manager of the company, Mr. N. C. Marshall, states:

Certain months are supposed to be dry, but they will not be so regularly every year. The day rainfall is fairly constant, at an average of from 4 to 6 inches per month. The only thing that can be said about the night rainfall is that more rain falls from

June to November than during the other months of the year. This includes the time when the big floods come down the San Juan and Condoto Rivers, which may be expected during the months of September to November, and much less frequently during the other months. What dry season there is will come from December to May, although it can not by any means be called dry.

In regard to the rainfall during the day, the greatest part of it falls from 7 to 9 o'clock in the morning and from 5 to 7 in the evening. If it were otherwise, it would be very hard to get any outside work done at all, but there are really more sunshiny days than the record of rainfall would lead one to suppose.

It is rather uncommon for rain to continue falling all day long and if these days were kept track of, I think that it would be found that the most of them occur during the months of heaviest rainfall from June to November. For this reason this time of the year has been called the wet season, and from December to May the dry season, but the rain gage does not bear this out; as, for instance, the second highest monthly rainfall on record, 39.15 inches, occurred in April.

The native way of naming the seasons is very simple and quite flexible; when a few consecutive days are rainy they say it is winter, and when four or five days have been bright and sunshiny they call it summer, no matter what time of the year it may happen to be.

C. E. P. BROOKS ON VARIATIONS OF PRESSURE FROM MONTH TO MONTH IN THE REGION OF THE BRITISH ISLES¹

551.54 (41)

By A. J. HENRY

In this study the author has used the data of monthly deviations from normal pressure for the stations published in *Réseau Mondial* to trace the shifting in latitude and longitude from month to month of the centers of greatest deviation in the region of the British Isles. Only the pressure deviations were dealt with, since those of temperature and precipitation can be explained in terms of the pressure.

The monthly charts afforded little insight into the pressure distributions which were responsible for them; hence it became necessary to examine the daily weather charts for the months considered.

In the beginning the progressive movement of these centers was studied by constructing a series of overlapping 30-day charts March 1 to 30, March 2 to 31, and so on. These charts very clearly showed the gradual movement in a northeasterly direction of the areas of excess or deficit. The construction of 30-day overlapping charts being too laborious, at the suggestion of Dr. George C. Simpson, a shorter method was adopted.

In this method the area covered was that between 30° and 70° north latitude and 70° west to 80° east longitude and only deviations of at least ± 5 mb. were considered. When deviations of that amount occurred in two successive months a barbed line was drawn connecting the position of the center during the first month with its position in the second month.

If these centers in successive months were as a rule quite independent of each other, there would be no reason why these arrows should be directed toward one point of the compass rather than another. If, on the other hand, the centers in successive months really indicate two successive positions of the same center, and if there is a tendency for centers to move in one direction rather than in another, the majority of the arrows should point in this direction. The investigation was carried out on three separate series of charts, which between them cover a period of 41 years:

(a) A series of monthly charts of pressure deviations over the northern hemisphere covering the years 1873 to 1900.

(b) Working charts of deviations of pressure over the globe for the period January, 1910, to April, 1919, prepared in connection with the *Réseau Mondial*.

(c) A series of rough working charts of the deviations of pressure over North America, the North Atlantic, western and central Europe, covering the period June, 1922, to October, 1925, pre-

Commenting on the large amount of precipitation during the night hours, Mr. Westlake states:

With regard to the preponderance of precipitation during the night this is a feature of the climate which I have heard commented upon by the half-dozen or more engineers whom we have sent to Colombia since 1912. In fact this feature of the climate of the Choco region was noted and commented upon as far back as 1854 in an article by John C. Trautwine (author of the well-known engineering handbook and one of the builders of the Panama Railroad) in a paper entitled "Rough Notes of an Exploration for an Inter-Oceanic Canal Route by Way of the Rivers Atrato and San Juan, in New Granada, South America, see journal of the Franklin Institute, March to October, 1854."

The only records of relative humidity are those at noon covering parts of the years 1917 to 1919. No data appear for August or September of any of those years. Interpolation of values for these months gives the unusually high value of 82 per cent at noon for the annual mean. The extremes of the monthly means are 86 per cent in February and 78 per cent in October.

pared in connection with various investigations into current weather.

The *Réseau Mondial* charts were the first set to be dealt with, and it was quickly evident that the movements of the centers in the southern half of the area were very largely from west to east, while in the northern half there were a considerable number of instances in which the movements were apparently from east to west. The work was accordingly repeated, the pairs of months being separated into two classes, the first class including those in which the position of the center during the first month was north of 55° N., while the second class included those in which the position of the center during the first month was south of 55° N. The results of the investigation are shown in Table I (not reproduced). * * *

From Table I we see that between 70° and 55° N. 60 centers of excess gave an apparent movement to the eastward compared with 35 to the westward, and 60 centers of deficit showed a movement to the eastward compared with 49 to the westward. Between 55° and 30° N. 41 centers of excess showed a movement to the eastward compared with 15 to the westward, and 23 centers of deficit showed a movement to the eastward compared with 16 to the westward. In all four groups the easterly movement predominated, although to a much greater extent with centers of excess than with centers of deficit.

The predominance of apparent easterly movement holds in all four seasons, though it is greatest in summer. We find that for each 10 centers of pressure deviation giving apparent westward movement in any one season the number of centers giving an apparent movement to the eastward is: Winter 12, spring 17, summer 21, autumn 16. Many of the instances of apparent movement to the westward are due to the happening that a center of deviation which was shown in the chart for one month had by the following month either moved eastward out of the area or had decreased to an intensity of less than 5 mb., while at the same time a new center of deviation had appeared in the west of the chart. It appears in fact that the month is too big a unit; if the charts had been drawn for each 10 or 15 days, the predominance of apparent easterly movement would have been much greater.

Tracks of centers of excess and deficit were constructed and published. These followed more or less regular courses, somewhat analogous to the paths of cyclones that apparently circle the north pole. The centers of excess show a tendency to move from Alaska southward to the center of the United States, thence eastward to a position between Bermuda and Nova Scotia, continuing in that direction to the Azores, thence usually northeastward to the British Isles or across them to Scandinavia, and finally again eastward into northern Russia or the Kara Sea, the whole journey taking about six months, though no single center was found that persisted long enough to move from Alaska to Russia.

¹ Quarterly Journal of the Royal Meteorological Soc. 54: 263-276.